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(54) A heat exchanger for cooling a high temperature fluid

(57) A heat exchanger for cooling a high temperature fluid flowing along arrows (f_2) comprises walls (1) made of aluminum and secondary heat exchange elements (6) made of steel or any other high temperature withstanding metal and which are followed by further secondary heat exchange elements (7) made of aluminium.

FIG. 1

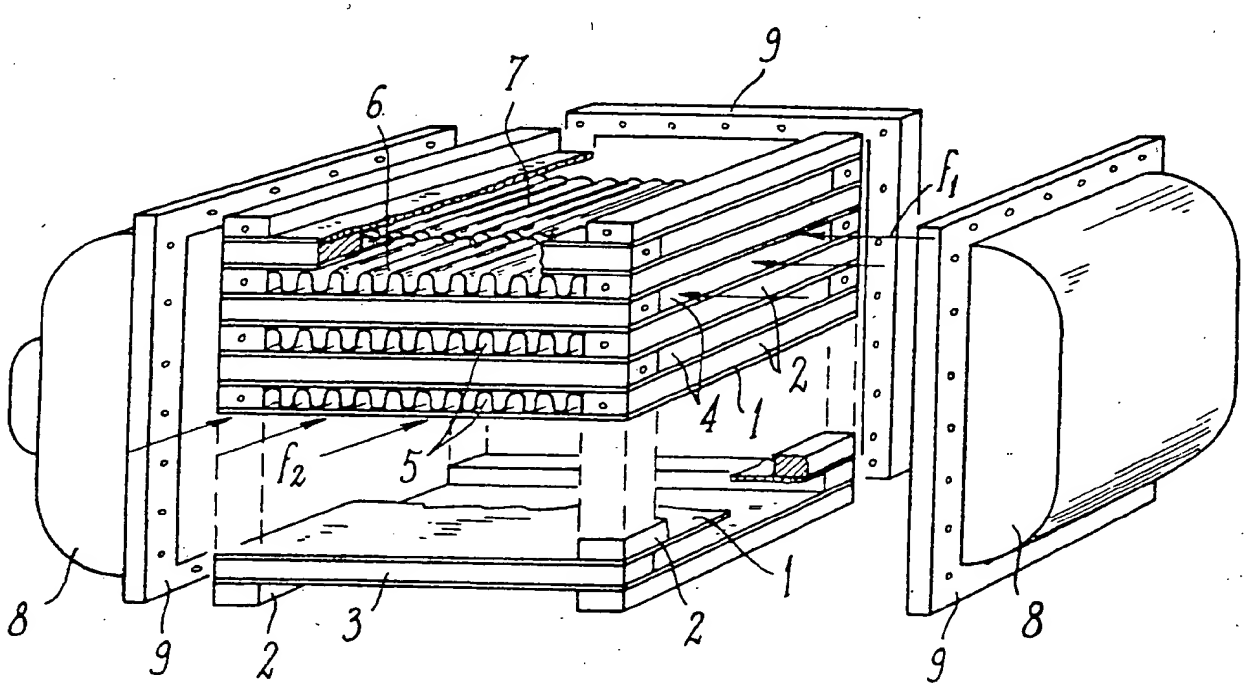

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Fig. 1

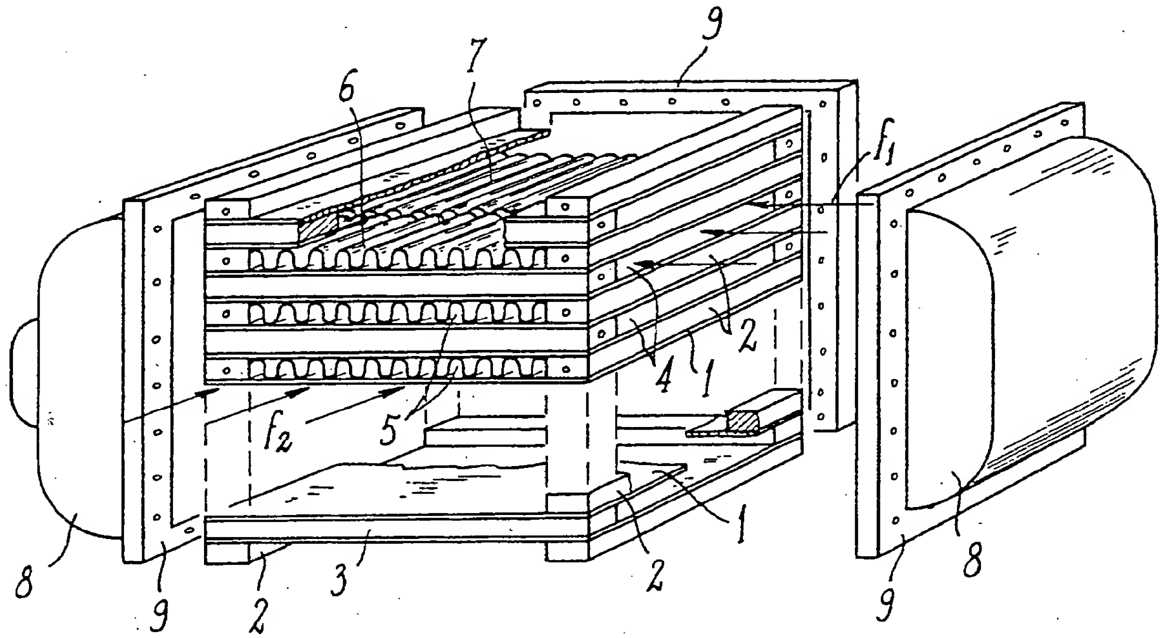
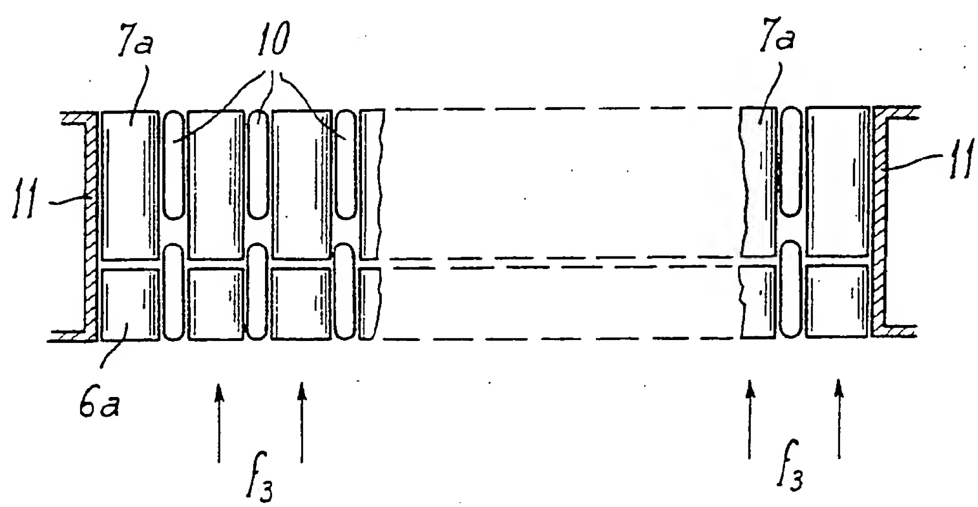


Fig. 2



SPECIFICATION

A heat exchanger for cooling a high temperature fluid

In various fields of the technique, there is the necessity of cooling down a gas, for example air, typically coming from a turbo-compressor and being at a high temperature, for example of the order of 300°C, for bringing said temperature down to about 100°C, or even less, by using a cooling water circuit, for example the cooling water of the supercharged engine, said water being at a temperature of 50° or 60°C.

For reaching such a result, high efficiency (80% in the example cited) heat exchangers are to be available.

On the other hand, the heat exchangers have to be made as compact as possible, for example plate and bar type heat exchangers comprising secondary heat exchange elements in the air circulation channels.

When designing such heat exchangers, the very stringent conditions of some applications where they are used is to be taken into account. Thus, in the case already mentioned of the cooling of a diesel engine supercharging air, not only the temperature and the pressure which reaches and even exceeds 7 bars in the present time embodiments, but also the vibrations caused by the engine are to be taken in account. For such equipments, one is therefore led to use stainless steel the thermal conductivity of which is rather poor, particularly when alloys which are more adapted to brazing are used and where said thermal conductivity falls down to 0.015 Kw/m.°C. This puts relevant restraints to the designing such as : a small height for secondary heat exchange elements, a substantial thickness for said elements, hence a high weight and high costs of these heat exchangers.

The U.S. Patent 3,552,488 concerns a plate-fin heat exchanger in which the plate is a continuous convoluted sheet which separates the fluids between which heat is to be transferred. Corrugated fins are juxtaposed between the convolutions of the plate and in heat-conducting contact therewith, the plate and fins thereby providing a high heat transfer surface area for efficient heat exchange. By providing a continuous convoluted plate, cross leakage between the fluids at any point along the plate surface is precluded. Further, the plates and fins can be formed by any material which is high in heat conductibility and the remainder of the heat exchanger can be constructed of the same or a different material for example of low heat conductivity.

The U.S. Patent 2,952,445 concerns a plate type heat exchanger of light weight and specially constructed for operation under high pressures and for resistance to air flow damage. Features of such concept lie in a means of fabrication wherein the fin material serves the dual purpose of more effectively transferring heat and of acting as tie strips positively to connect adjacent plates to one another. Also, an all brazed construction is contemplated obviating the need for separable connecting devices, and, still further, a generally new fin structure is characterized by the use of a relatively short length fin at the entrance end of the duct made of a heat treatable, damage resistant material and spaced from following fin material in a manner to define therewith a plenum chamber for lateral distribution of the flowing fluid.

The British Patent 1,050,287 concerns also fin plate type heat exchanger in which two parallel plate member passages are provided in each plate member, an entry tank and exit tank are provided at one end of the plate members, the entry tank being connected to one passage of each plate member and the other tank being connected to the other passage of each plate member, a common return tank provided at the other end of the plate members interconnecting the plate member passages.

The starting point of the invention is the established fact that it is possible to use a large quantity of aluminium alloys, the thermal conductivity of which reaches 0.2 Kw/m °C with a reduced voluminal mass, although the mechanical properties of these alloys decrease substantially over 150°C.

According to the invention, the heat exchanger for cooling a high temperature fluid is characterized in that the walls of the circulation channels of the cooling fluid are made at least in part of an aluminum alloy, whereas a portion at least of the circuit of the fluid to be cooled is made of a metal withstanding high temperatures, typically stainless steel, and in that the connection between the walls of the circulation channel and the portion at least of the circuit to be cooled is brazed.

Various other features of the invention will become more apparent from the following detailed description.

Figure 1 is an exploded perspective view of a plate type heat exchanger carrying the invention into effect, with parts cut away;

Figure 2 is a partial cross sectional view of a so-called tube and corrugated fin type heat exchanger, also carrying the invention into effect.

Referring now to the drawings, Fig. 1 shows a so-called plate type heat exchanger which comprises plates 1 spaced apart by sets of bars 2 and 3 respectively arranged at a right angle relative to each other.

Thus, the hereabove plates and bars define channels 4 for a first fluid flowing in the direction of arrows f_1, and channels 5 for a second fluid flowing in the direction of arrow f_2. The cooling fluid, for example the cooling

water of a supercharged engine fed with the cooled air, forms then the first fluid and is caused to flow in the direction of arrow f_1.

The channels 5 for a second fluid are provided at their inlet with a first type of secondary heat exchange elements 6 made of steel or stainless steel or any other similar metal withstanding high temperatures. The first type of secondary heat exchange elements 6, made of corrugated bands for example, as shown, is followed by a second type of secondary heat exchangers 7 made of a light alloy and constructed in a similar way as the first elements 6, although it is possible, if desired, that the corrugation pitch of the elements 7 is different to that of the elements 6. The length of the elements 6 is established by taking in account the inlet temperature of the second fluid flowing in the direction of arrows f_2 and so that the second fluid is sufficiently cooled down for not damaging the elements 7. When calculating the length of the elements 6, the temperature of the first fluid flowing in the direction of arrows f_1 is also taken in account. In this part of the heat exchanger, the disadvantage of using steel or stainless steel as regards thermal conductivity is not as severe due to the large temperature difference existing between the two fluids.

On the other hand, the separating plates between the channels have been found to be, due to the structure of the heat exchanger and of the thermal characteristics of the fluids used, as a temperature much closer to that of the cooling liquid than to that of the fluid to be cooled.

For this reason, the plates 1 are all made of a light metal, particularly aluminium, or an aluminium containing alloy, and the bars are preferably made of aluminium or of an aluminium containing alloy as long as the inlet temperature of the second fluid does not risk reducing the mechanical strength characteristics of said bars. If, due to the particular vibrations or other stresses to which the heat exchanger is subjected there is a risk of damage to the bars to be feared, then the bars 2 at least which define the flowing channels of the first fluid and which define also the opening of the circulation channels of the second fluid are made of the same metal or alloy as the elements 6, viz. preferably stainless steel. It is also possible that all the bars are made of stainless steel.

The hereabove embodiment allows to manufacture extremely compact apparatus due to the good conductivity of the light alloys forming the heat exchange parts which are essential in the heat exchanger, viz. the secondary heat exchange elements 7 and the plates 1.

When the bars 2 and 3 are made of stainless steel for reasons of mechanical strength, the overall size of the heat exchanger is not modified and only its weight is increased.

For manufacturing the hereabove defined heat exchanger, all the parts are conected by a brazing operation preferably using the brazing method described by Applicant in French Patent 6,943,387, i.e. that the stainless steel parts are successively pickled, flushed and subjected to fluxing by being dipped in an aqueous solution, then dried. On the other hand, the aluminium parts are degreased and pickled.

The various parts described hereabove are then assembled and subjected to the brazing operation as such, which can be performed either in a salt bath or in an oven.

Distribution boxes 8 with flanges 9 are finally fixed, for example, by screws, in the assembly formed by the stacking of the bars 2, 3 and plates 1.

Fig. 2 shows an other embodiment of a heat exchanger comprising circulation tubes 6 arranged in a core and coming into tube end plates, not shown since they are well known in the art and may be made in many different ways.

The first fluid, viz., in the example previously considered, the cooling water of a supercharged engine, is driven to flow in the tubes 10, and the second fluid is driven to flow in the direction of arrows f_3 transversely to the tubes. As in the previous example, secondary heat exchange elements 6*a* made of a metal withstanding heat, typically steel or stainless steel, are placed on the front portion of the core between the tubes, these elements 6*a* having possibly the shape of corrugated bands, and secondary heat exchange elements 7*a* made of a light alloy are arranged after the elements 6*a*.

As in the previous example, the shape of the elements 7*a* can be the same as that of the elements 6*a*, or different, particularly as regards to the pitch of the corrugations. The hereabove described core is brazed in the same manner as previously described. The core assembly is maintained inbetween side flanges 11 which can be connected to the tube-end plates (not shown).

The invention is not limited to the embodiments shown and described in detail, and numerous modifications may be carried out without departing from the scope of the invention. In particular, the secondary heat exchange elements made of stainless steel or another metal or alloy withstanding high-temperatures may be formed with louvers or other cuttings for increasing their efficiency.

CLAIMS

1. A heat exchanger for cooling a high temperature fluid, comprising cooling fluid circulation channels having walls made at least in part of an aluminium containing alloy whereas a portion at least of a circuit of a fluid to be cooled is made of a metal withstanding high temperatures, typically stainless steel, connecting between the walls of the

channel and the portion at least of a circuit to be cooled being brazed.

2. A heat exchanger according to claim 1, comprising a plate and bar type core, the plates being made of an aluminium alloy.

3. A heat exchanger according to claim 1, wherein secondary heat exchange elements made of a metal withstanding high temperatures are arranged at inlet of the circuit of the fluid to be cooled, said elements being followed by other secondary heat exchange elements made of an aluminium containing alloy.

4. A heat exchanger according to claim 2, wherein at least the bars of the plate and bar type core which define the cooling fluid circulation channels and which define opening of the circuit of the fluid to be cooled are made of stainless steel.

5. A heat exchanger according to claim 1, comprising a tube and corrugated plate type core, a first type of secondary heat exchange elements being provided at front of the core and being made of a metal withstanding high temperatures, typically stainless steel, and being followed by a second type of secondary heat exchanger made of a light alloy.

6. A heat exchanger according to claim 5, wherein the tubs are made of a light alloy.

7. A heat exchanger for cooling a high temperature fluid, substantially as hereinbefore described with reference to Fig. 1 or Fig. 2 of the accompanying drawings.

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